Less is more: rarity trumps quality in luxury markets

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The international market for luxury goods has almost doubled since 1990, with a worldwide increase of 10% annually[1]. This trade is fuelled by a great deal of legally and illegally exploited wildlife species, putting enormous pressure on many of them, with potentially irreversible consequences. The dramatic decline of sturgeon populations[2,3], exploited for their caviar, is a good example: all 27 species are threatened and the most coveted are on the verge of extinction. We aim to identify the mechanism responsible for the continued overexploitation of sturgeon species, despite caviar's ever-increasing price and the imminent loss of these species. Here, we demonstrate consumer preference for rarity over intrinsic quality: customers tasting two caviar samples more often chose the one they thought was rare, although both were identical. In a game theory model, we demonstrate that the most rational behaviour is to rush to consume rare species, even though this precipitates their extinction. We conclude that the human predisposition to place exaggerated value on rarity probably drives the entire market for luxury goods from reptile skins to exotic woods. Our findings suggest that allowing low levels of legal trade will exacerbate the arbitrary value of rare species and thereby stimulate demand. Only a total ban on trade from the wild (with very strict controls) combined with strong support for farmed equivalents will protect rare species.

The trade of all 27 species of sturgeon has been restricted by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1997. Despite their well-publicized imperilled status and publication of quotas, extreme commercial pressure on 15 species persists[3], fuelled by a rising demand and thriving illegal trade[4,5]. In the Caspian Sea, where 90% of caviar comes from[6], the sturgeon population has plummeted by 90% over the past two decades[3,5].

Standard economic theory predicts that exploitation alone is unlikely to result in extinction of a species because of the escalating cost of finding the last individuals of a declining species. According to this theory, economic extinction, i.e. the cessation of exploitation, should precede ecological extinction, i.e. population or species disappearance, giving it a chance to recover to exploitable levels[7]. But in the case of sturgeon, exploitation remains highly profitable (the global legal trade in caviar is currently worth several hundred million US dollars annually[3]) and prices (which reflect the demand) increase as sturgeon stocks deplete and become rarer (Figure 1). At this rate, specialists estimate, there will be virtually no more sturgeon left in the Caspian Sea by 2012[9].

Caviar consumers' attraction to rarity

To try to identify the mechanism responsible for the overexploitation that is quickly driving the 200-million-year-old sturgeon fish to extinction, we first tested consumers' predisposition to place a high value on rarity by investigating whether the perceived rarity of caviar was more important for consumers than its intrinsic gustative qualities. When presented with caviars from both a 'rare' species and a 'common' species, 57% of the consumers interviewed in luxury receptions in France explicitly expressed an *a priori* preference for the rare species caviar, even before they tasted either sample (Pearson Chi-square Homogeneity test: $\chi^2 = 6.02$, df = 1, $p < 0.0001$, n = 307). No one expressed an *a priori* preference for the common caviar (Figure 2a).

Having tasted the two samples, a large majority (86.1%; Pearson Chi-square Homogeneity test: $\chi^2 = 111.01$, df = 2, $p < 0.0001$, n = 316) formulated a preference for one of the two samples, despite the samples being strictly identical. Among this majority, 70.2% preferred the rare species caviar (Figure 2b; Pearson Chi-square Homogeneity test: $\chi^2 = 44.49$, df = 1, p < 0.0001, n = 272). When asked to give a mark to each sample to judge its gustative quality, consumers scored the caviar of the rare species significantly higher than the common one (14.96 +/- 2.6 vs. 13.42 +/- 2.94; n = 272; LME model; F = 49.017, df = 1, p < 0.0001; Figure 2c). The preference for the rare caviar did not vary with the frequency of consumption of caviar by the interviewees in the luxury receptions (GLM; $\chi^2 = 3.943$, df = 3, p = 0.27, n = 271; Figure 2d).

Similar results were obtained with consumers interviewed in supermarkets: 52.3% expressed a positive *a priori* and 74.2% a confirmed preference for the rare caviar. The rare species caviar also obtained higher grades than the common species caviar (Linear mixed-effect model; F = 0.164, df = 1, p = 0.69, n = 515; see the Methods section for details of the statistical analysis).

Our findings with both novice and regular caviar consumers demonstrated an irrational preference for caviar they believed came from a rare species, although both the rare and common samples came from the same can. This suggests that for French caviar consumers (the largest importers of caviar in the world) rarity is more important than intrinsic gustative quality. This striking preference, among people renowned for their taste for luxury products and their sophisticated palates, is likely to hold also for consumers outside France.
The artificial value placed on rare products probably drives the entire luxury goods market, in which interpersonal motives[10], reflecting the consumers' self-consciousness[11] and social influence, play a major role for prestige-seeking consumers.

Optimal strategy for consumers seeking rarity

We next established a model based on the principle of the prisoner's dilemma game, to identify the most rational behaviour (i.e. consume now or postpone consumption) of consumers attracted by a rare resource, such as caviar, in order to optimise their payoff (i.e. satisfaction) over time. This game-theory model shows that the expected payoff of consuming later, for the sake of sustainable resource management, is always lower than the expected payoff of consuming now, whatever the choice of other consumers (Figure 3a and b). This model also shows that when a species is rare, the rationality of rushing to consume instead of waiting increases as more consumers decide to consume (Figure 3b). This principle of diachronic rationality (or rationality over time) explains, at least in part, why people exhibit such seemingly irrational behaviour towards sturgeon exploitation.

Demographic consequences for rare species

Finally, we built a deterministic model to investigate the demographic consequences for the exploited species of the consumers' attraction for rare resources. The model demonstrates that this consumption pattern triggers an anthropogenic Allee effect: a human-generated mechanism that leads the exploited species into an extinction vortex[12]. This process was named by analogy with the Allee effect[13], a mechanism by which plants or animals have a lower fitness in small populations than in larger populations. This can translate into lower population growth rates (and even negative growth rates) at low densities, ultimately driving these populations to extinction. Here, the human attraction for rarity fuels a disproportionate exploitation of the resource, rendering it increasingly rare and thus ever more desirable, until total depletion (Figure 4).

The phenomenon we describe here presents a dramatic risk for biodiversity in general: it seems that any species, exploited for whatever reason, can turn into a rare and coveted species exposed to extinction risks. It is the case for sturgeon caviar, which used to be very inexpensive when common, was consumed in enormous quantities by Russian nobility and served in the 1900s in American bars for a penny a pound to make consumers thirsty. It may also be the case for many other delicacies, such as the abalones *Haliotis sp.* and the lips of the Napoleon wrasse *Cheilinus undulates* (a single pair of lips costs US$250). Other wildlife products are also concerned: exotic woods (mahogany, ebony), reptile skins (snakes, crocodiles, lizards), furs and leather hides (wild cats, antelopes) used for luxury clothes and accessories. For example, the demand for shahtoosh shawls made from the wool of the Tibetan antelope (*Pantholops hodgsonii,* also called chiru), caused the global population of chirus to crash over the last 50 years[14,15]. As they become more rare, these animals may be increasingly overexploited.

The tendencies of both confirmed and novice caviar consumers to prefer rare species suggests that this predilection is not restricted to current consumers but that anybody reaching a sufficient level of wealth to afford luxury items would probably respond in this way. This finding is especially worrying as the general level of world wealth grows. The luxury market has expanded continually over the past 25 years due to people's growing materialism[10,16], their increased buying power[17], and the recent tendency towards 'democratisation' of luxury[18]. The emerging economies of Brazil, Russia, India and China are also greatly swelling the number of consumers able to enter this market[19]. For example, by 2011 a quarter-billion consumers will make China the world's largest consumer of luxury goods[20]. This will undoubtedly dramatically increase the pressure on wildlife species that are already rare or likely to become rare.

As rarity itself plays a major role in the value of many wildlife-based luxury goods, such as caviar, applying low quotas would make these species even more rare and would thereby only exacerbate their attractiveness. This would boost the demand, potentially fuelling the illegal trade. Unregulated trade would likely doom a species even more rapidly. Therefore, its seems that a total moratorium on the trade of wild specimens of rare species while boosting the trade of farmed equivalents might be the most effective course of action to protect species involved in luxury markets from this fatal human attraction for rarity.

Methods Summary

Tasting sessions

We conducted three tasting sessions during private Parisian luxury receptions hosting guests belonging to the upper socio-professional classes. We proposed simultaneously two samples of caviar to 316 volunteer consumers. The caviar offered (*Acipenser baeri* caviar) came from a French sturgeon-breeding farm (Sturgeon company). One sample was labelled as coming from a ‘rare species’ of sturgeon, and the other as coming from a ‘common species’ of sturgeon. In fact, both samples came from the same can. Consumers were asked to taste both caviars, but chose the sample they wanted to taste first. Tasting was followed by a short questionnaire in which the consumer was asked to (i) give and justify his/her preference, if any, (ii) give a mark out of 20 to each of the caviars, (iii) justify the choice of the first caviar tasted, and (iv) indicate the frequency at which he/she usually ate caviar.

As a control, we also conducted three sessions in three large supermarkets located in the suburbs of Paris, where customers were more representative of the average French consumer, i.e. a non caviar-consuming public. In total, 308 customers were interviewed there. The experimental design was similar to that for the luxury receptions.

Optimal strategy for consumers seeking rarity?

We first built a two players payoff matrix in order to identify the optimal strategy for a consumer attracted by a resource that can be depleted by consumption. This game, akin to a prisoner's dilemma game, is dominant solvable (i.e. there is an evolutionary stable strategy). We then modified it into a second matrix, with n players and a possibility for the consumers to modify their own strategy when they observe the others (see Figure 3 for details).

Demographic consequences for rare species

We devised a macroscopic model, adapted from the classical logistic model, in order to study the consequences of the behaviour of potential consumers (players) on the dynamics of the exploited population. In this model, each player could choose at each time step to start consuming an individual from the exploited population or wait until the next time step. We supposed that consumers were aware of others' decisions and that they could influence each other. The behaviour of the players was given by the game theory model and each player removed one individual from the exploited population at each time step. Figure 4 shows that populations below a rarity threshold are exploited by increasingly more consumers as their numbers decrease, which eventually drives them to extinction (see the legend to Figure 4 for details of the model).

Methods

Tasting sessions: details of the experimental design

We proposed to consumers a high quality caviar that had previously been evaluated as excellent by a jury of French experts[21]. Each can of caviar used for the experiments was divided vertically in two halves, which were subsequently presented in two strictly identical display bowls. This way, the only (apparent) difference between the two caviars was the label (‘rare species’ or ‘common species’), and any other difference in flavour, aspect, smell or presentation was avoided. We regularly switched the position of the two labels to avoid an effect of the initial position of the samples (which was subsequently tested and found not to be significant).

Statistical analyses

Selection of variables affecting consumers’ preference

We first tested for potential effects of methodological variables on the choice made by consumers in each of the two tasting session categories (i.e. luxury reception or supermarket). The following variables were considered in one linear logistic multivariate model: gender of the consumer, identity of observer ($n = 8$), position of the label rare (i.e. to the right or to the left of the consumer), session (i.e. session 1, 2 or 3), and the sample tasted first. We selected a minimum adequate model with a stepwise procedure by exact AIC (Akaike's information criterion) and tested for significance of these variables on the preferences expressed by the consumers for either caviar (tests of significance were performed with F-tests based on the usual Restricted Maximum Likelihood conditional estimate of the variance). Only the order in which consumers tasted the two samples was selected by the stepwise procedure to have a significant effect on the preference (see Figure 2b). Using the same method, a second linear logistic multivariate model allowed us to explore whether the choice of the first sample tasted might have been influenced by a positive *a priori* in favour of the rare species sample and by the consumers' profile (i.e. their consumption frequency). The potential effect of the consumers' profile was only tested, in luxury receptions. Overall, only the effect of a positive *a priori* for the rare species sample was selected by the models as a factor influencing the choice of the first sample tasted.

Quality appreciation of the two caviar samples

Marks did not follow a normal distribution (Shapiro-Wilk test for normality; $W = 0.95$; $p < 0.0001$; $n = 1030$), but fitted a gamma distribution (Adequacy LR test; $\chi^2 = 0.279$; $p = 0.87$; $n = 1030$). To compare the marks given to the two samples by each consumer, we defined a linear mixed-effect (LME) model fit by maximum likelihood, with the sample label 'rare' or 'common' as the fixed effect and the individual as a random effect.

Software

Statistical analyses of the data obtained were performed using JMP 5.0.1 (Sas, Institute Inc, 2002) and R 2.1.1 software. Continuous data are described through their mean and standard deviation (mean +/- SD). The alpha level was set at 0.05.

Payoff matrix model

The second matrix (Figure 3b) displays expected payoffs for focal consumer A, depending on his own strategy and the strategies adopted by the n other potential consumers, which A is assumed to observe. A is assumed to decide at time t whether he shall consume immediately or postpone his consumption until $t+\tau$. Consuming lasts until the end of the game.

If A observes i consumers ($0 \leq i \leq n-1$) at t, expected payoff of postponing consumption is $X.P_\tau^i - Q_\tau^i$, unless the exploited resource is depleted before $t+\tau$, in which case payoff is 0. Here, $Q_\tau^i = \sum_{k=i,n-1} R_{\tau\, i}^{\ k}.c^k$, and $R_{\tau\, i}^{\ k}$ is the probability (estimated by A) that there will be k consumers at t+τ, given that there are i consumers at t (for a definition of the other parameters, see Figure 3).

c^i is an increasing function of i, as competition intensifies with the number of consumers. Hence X- c^i is a decreasing function of i. Similarly, $X.P_\tau^{\,i} - Q_\tau^{\,i}$ is a decreasing function of i. Moreover, for $(0 \leq i \leq n\text{-}1)$, $X.P_\tau^{\,i} - Q_\tau^{\,i} < X - c^i$ (this is because for $i \leq j \leq n\text{-}1$, $R_{\tau\,i}^{\,j} \leq 1$, as there are at least as many consumers at t+τ than there were at t). This leads to the matrix structure showed on Figure 3B, which determines the dominant strategy for A.

References

1. Nueno, J. L. & Quelch, J. A. The mass marketing of luxury. *Business Horizons* **41**, 61-68 (1998).
2. Pala, C. Endangered species: ban on beluga caviar points to sturgeon's worldwide decline. *Science* **310**, 37 (2005).
3. Pikitch, E. K. et al. Status, trend and management of sturgeon and paddlefish fisheries. *Fish and Fisheries* **6**, 233-265 (2005).
4. Speer, L. et al. Roe to ruin: the decline of sturgeon in the Caspian Sea and the road to recovery (Caviar Emptor, www.caviaremptor.org, 2000).
5. Stone, R. Central Asia: Caspian ecology teeters on the brink. *Science* **295**, 430-433 (2002).
6. Stone, R. Science in Iran: the sturgeon's last stand. *Science* **309**, 1806 (2005).
7. Clark, C.W. *Mathematical bioeconomics: Optimal management of renewable resources* (Wiley, Hoboken, New Jersey, 1990).

8. Catarci, C. World markets and industry of selected commercially-exploited aquatic species with an international conservation profile (Food and Agriculture Organization of the United Nations, Fisheries circular No. 990, 2004).
9. Pala, C. Endgame for the Caspian sturgeon. *Front. Ecol. Environ.* **5**, 348 (2007).
10. Vigneron, F. & Johnson, L.W. A review and a conceptual framework of prestige-seeking consumer behavior. *Academy of Marketing Science Review* **1**, 1-15 (1999).
11. Brinberg, D. & Plimpton, L. Self-monitoring and product conspicuousness on reference group influence. *Adv. Consum. Res.* **13**, 297-300 (1986).
12. Courchamp, F. et al. Rarity value and species extinction: The Anthropogenic Allee Effect. *PLoS Biology* **4**, e415 (2006).
13. Courchamp, F., Clutton-Brock, T., & Grenfell, B. Inverse density dependence and the Allee effect. *Trends Ecol. Evol.* **14**, 405-410 (1999).
14. Harris, R. B., Pletschera, D. H., Loggersb, C. O., & Millerc, D. J. Status and trends of Tibetan plateau mammalian fauna, Yeniugou, China. *Biol. Conserv.* **87**, 13-19 (1999).
15. Mallon, D.P. Pantholops hodgsonii, Available from the International Union for Conservation of Nature and National Resources at www.iucnredlist.org, (2003).
16. Powderly, J. & MacNulty, C. Consumer trends: a turbulent time ahead. *Marketing* **Oct 11**, 33-34 (1990).
17. The World Bank Group. Available at http://go.worldbank.org/3QT2P1GNH0, (2008).
18. Dubois, B. & Laurent, G. The new age of luxury living. *Financial Times Mastering Management Review* **June**, 32-35 (1998).
19. Wong, N. Y. & Ahuvia, A. C. Personal taste and family face: luxury consumption in Confucian and western societies. *Psychol. Market* **15**, 423-441 (1998).
20. Ernst & Young. China: The New Lap of Luxury (2005).
21. Leygnier, A. & Victoria, R. in 60 Millions de Consommateurs (1999), **334**, pp. 18-23.

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Author Contributions

AG and FC set up the experimental protocol, performed the experiments and wrote the manuscript. AG conducted the statistical analyses. YM designed and analyzed the mathematical models. FC conceived and designed the study.

Figure legends

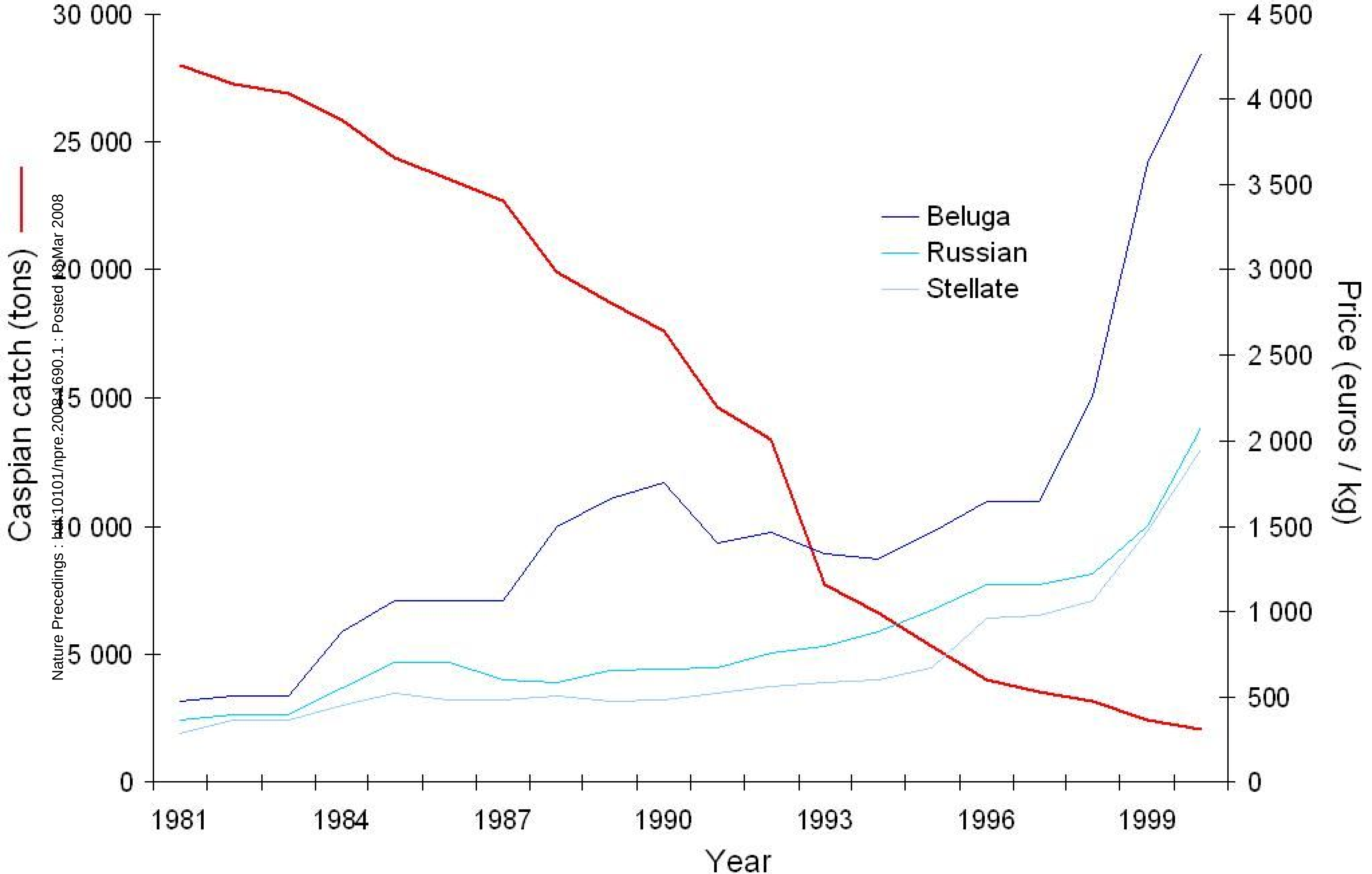
Figure 1. Increase in the price of three caviars as sturgeon stock in the Caspian Sea were depleted over the period 1981–2000. The Beluga (*Huso huso*), the Osetr (*Acipenser gueldenstaedtii*) and the Sevruga (*Acipenser stellatus*) caviars are the most coveted in the world. All three species are listed as endangered on the CITES red list since 1996. For each caviar, the price is inversely correlated (inverse cubic relationship) to the size of the stock (for Beluga, Osetr and Sevruga caviars respectively, $R^2 = 0.3913$, $p = 0.0032$; $R^2 = 0.554$, $p = 0.0002$; $R^2 = 0.5542$, $p = 0.0002$). Catch data obtained from Ref. 8.

Figure 2. Preference of consumers for rare caviar. a, Proportion of consumers who had a positive *a priori* for the rare species caviar even before tasting the samples. **b**, Post-tasting preferences. **c**, Marks they attributed to the two samples. **d**, Effect of consumer profile on expressed preference for rare or common species caviar. The existence of a positive *a priori* for the rare species caviar determined which sample the consumers chose to start with. This in turn determined the final preference expressed by the consumer. These results were similar whether the experiments were conducted in luxury receptions or in supermarkets (see the Methods section for details of the statistical analysis). The symbol '***' indicates a p-value < 0.0001; 'ns' stands for 'non significant'.

Figure 3. Game theory models demonstrate the benefit of consuming now rather than postponing consumption of rare commodities. a, Matrix of a simple two-player game theory model in which both players can either consume now or postpone consumption to the next time step. **b,** Equivalent matrix with n players, where A chooses to consume either now (t) or later ($t+\tau$) while knowing how many consumers will consume the resource now. This model accounts for the decrease of the elementary gain X through the competition with i other consumers, (c^i), the probability (estimated by A) for the resource not to be depleted at $t+\tau$

when i players consume at t, (P_τ^i), and the corresponding expected value of c^i, (Q_τ^i). In both matrices, the rational strategy is to consume now, until extinction.

Figure 4. **Trend of exploited populations of size N and per capita growth rate Θ** (i.e. dN/Ndt), when their dynamics are given by dN/dt=rN(1-N/K)-i and the change in consumer numbers is given by di/dt=[φ+iψ].[n-i]. We obtained Θ by solving these two equations. r is the intrinsic growth rate of the exploited population and K its carrying capacity. Among the n players (potential consumers), there are i consumers at time t, φ is the number of players who consume the exploited species irrespective of what others do, ψ is the increment in the number of players who consume due to the other's choice to consume. This graph shows the relationship between the population growth rate and its size with time, when the population is rare (red lines) and when it is not (blue line). The initial conditions are symbolised by the coloured circles, and the trend, towards N=0 (red lines) or Θ=0 (blue line), is shown by black arrowheads; when i=n or i=0, all possible initial conditions are along the line. While under this model populations that are not rare are not exploited and keep a positive growth rate until K, exploitation of a rare population decreases its growth rate. Below a given population threshold (here arbitrarily set at N=20), there are increasingly more players deciding to consume without waiting, until all do so (i=n; here at N=15). Exploitation amplification drives the population to extinction.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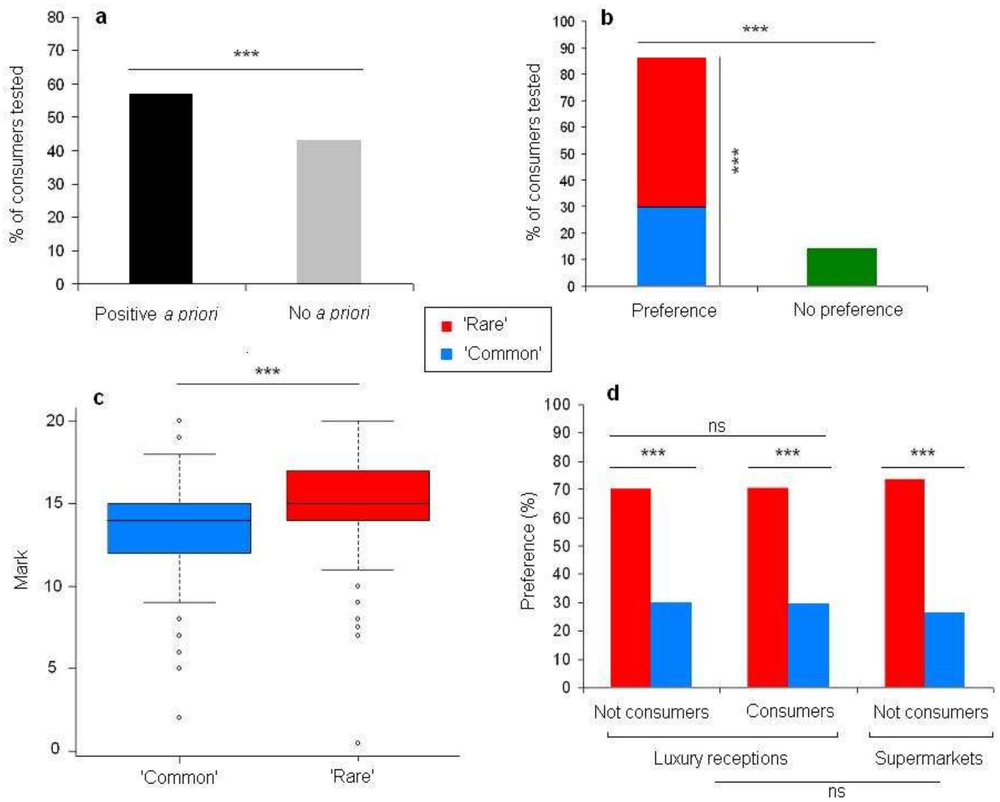
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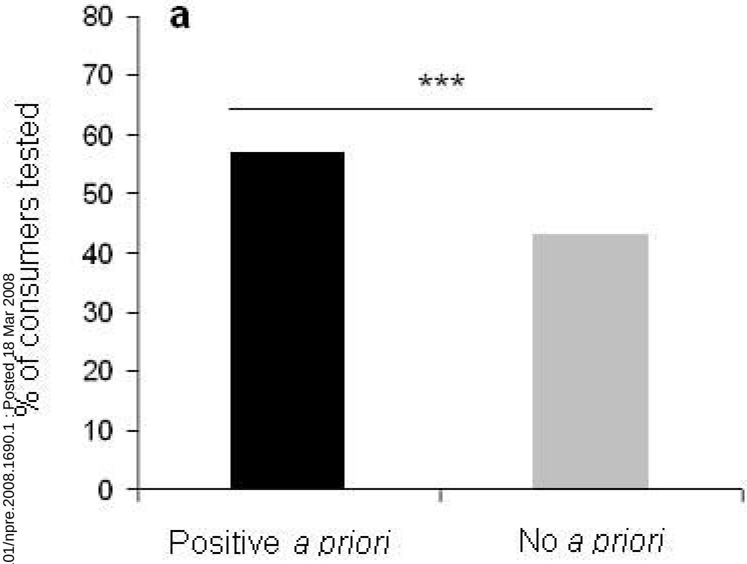
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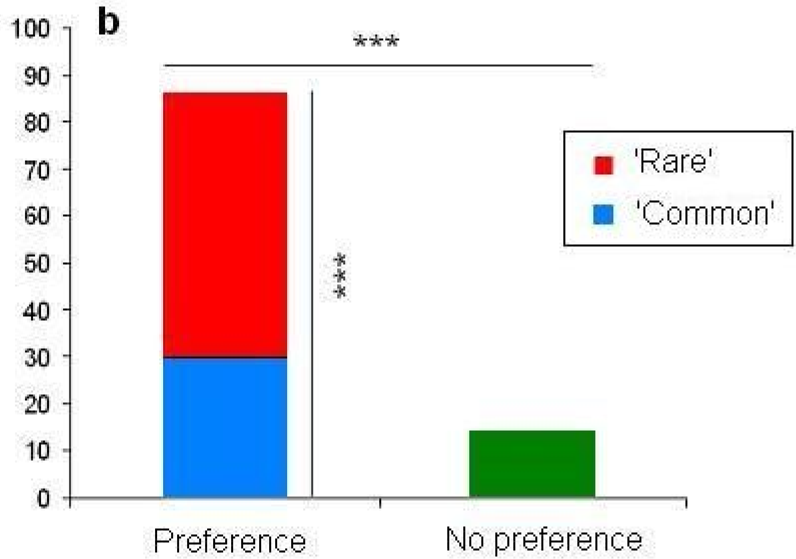
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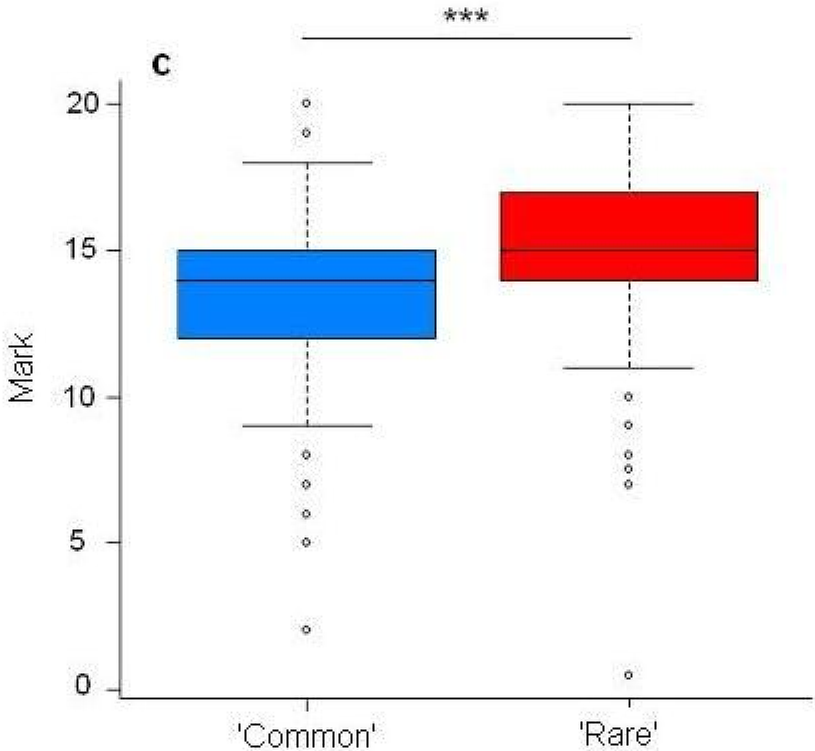
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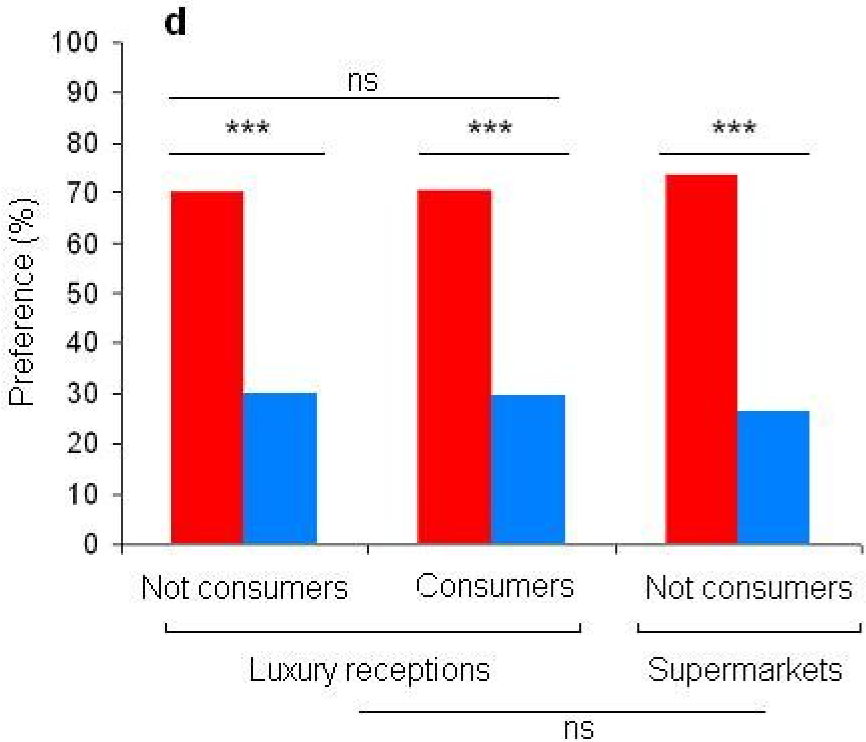
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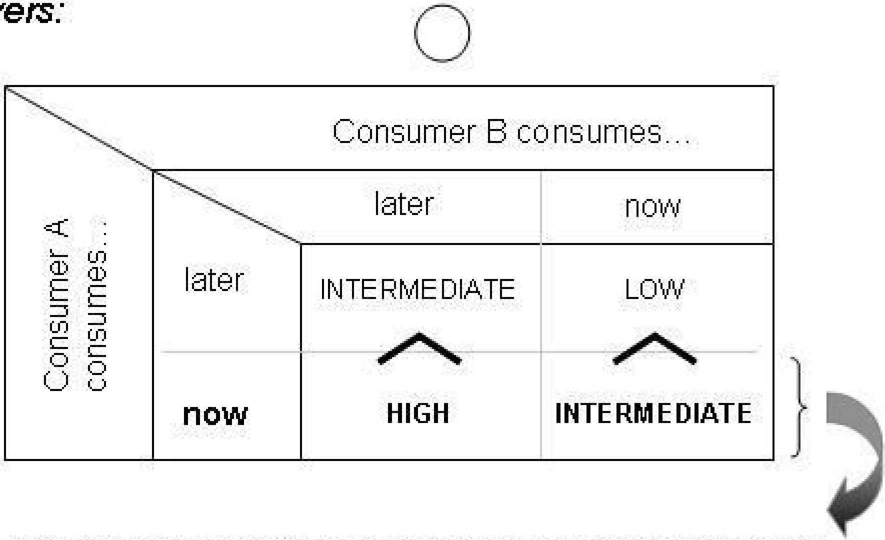

Expected payoff of A always higher when consuming now

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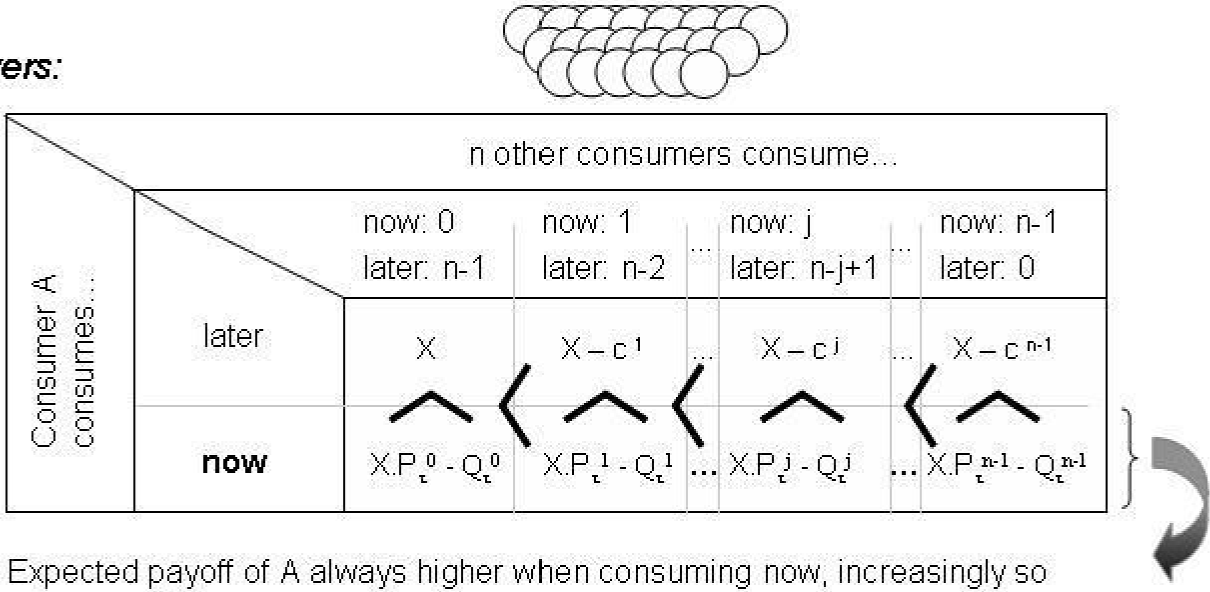

Expected payoff of A always higher when consuming now, increasingly so as more other consumers consume now

Common species: $\Theta(N,t) = r\left(1-\dfrac{N}{K}\right)$

Rare species: $\Theta(N,t) = r\left(1-\dfrac{N}{K}\right) - \dfrac{n}{N} \cdot \dfrac{e^{(\varphi+\psi.n).t}-1}{e^{(\varphi+\psi.n).t}+\psi.n/\varphi}$